MACHINERY MESSAGES

A Chilean copper plant uses Bently Nevada's Machinery Management software to maximize productivity

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The Chilean Copper Corporation (CODELCO) is composed of five divisions: Chuquicamata, El Salvador, Andina, El Teniente, and Radomiro Tomic. The Chuquicamata division owns the world's biggest open pit copper mine, which produces 670,000 tons per year of 99.9% pure copper. A pyrometallurgical (high temperature) process is used to extract the copper from the ore. Highly contaminating sulfur and arsenic fumes are produced as a byproduct.

Fortunately, CODELCO's five acid gas recovery plants prevent the discharge of sulfur and arsenic fumes into the atmosphere and produce 4,500 tons of 96% pure sulfuric acid per day. Most of the acid is used in the plant's process, but excess acid is sold to other plants in the region. High-speed AC turbo-blowers, with one-stage overhung impellers, are located in each acid plant. The blowers capture and compress the sulfur and arsenic fumes coming out of the copper producing furnaces, converting them into sulfuric acid. However, the blower rotors are very sensitive to unbalance caused by the fumes, which are very corrosive and abrasive.

The three largest blowers in the Chuquicamata plant are monitored by Bently Nevada 3300 Vibration Monitors and XY proximity probes. Four years ago, a Bently Nevada Dynamic Data Manager® 2 (DDM2) System was installed by Turbomecánica, Ltda. The system automatically collects and processes machinery data during steady state conditions from four Dynamic Data Interface (DDI) units, two Process Data Manager® (PDM) Communications Processors, a network, and two display computers (Figure 1). The DDI performs data acquisition and temporary data storage, and communicates with the Bently Nevada DDM2 display computers.

Process Data Correlation

During startup and warm-up periods, compressor flow is 80,000 Nm^3/hr,

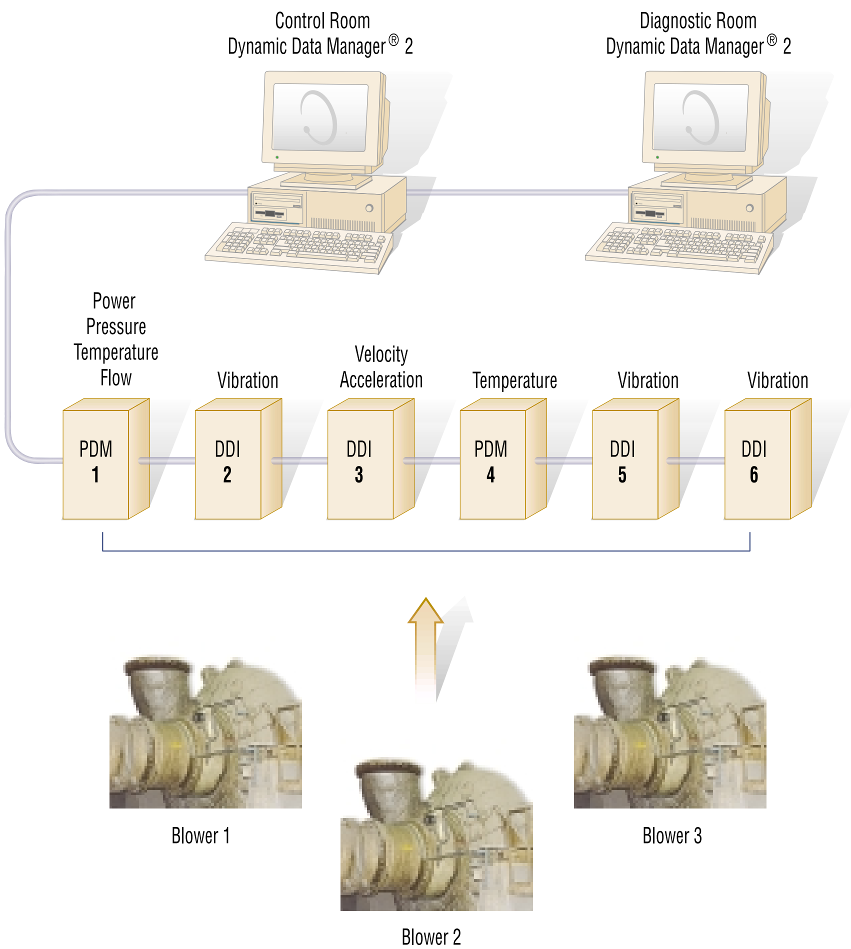

Figure 1. Vibration and process parameter monitoring system for acid recovery blowers.

Chuquicamata Copper Mine, Chile, the world's largest open pit copper mine.

which is less than 50% of nominal flow. Under these conditions, overall vibration often exceeds Alert levels. Highly turbulent flow and possible rotating stall are normally the cause. In order to identify any mechanical malfunction at this critical stage, process data correlation plots between vibration and flow are examined in conjunction with orbit and timebase plots. High vibration excursions are normally correlated to temporary low flow conditions.

Bearing temperatures are also correlated to vibration, which is associated with hot alignment conditions. Cold misalignment symptoms disappear as temperature increases. These phenomena can be readily seen by examining the power, pressure, temperature, and flow parameters brought into the DDM2 software via the PDM communications processors. Bearing metal temperature problems, especially with new bearings, can also be detected and corrected by correlating to historical data.

Before this machinery management system was in operation, every blower in the plant experienced unacceptable vibration levels at least twice a year. The cause was unbalance, due to corrosion, abrasion, and particle buildup on the impeller. When on-site cleaning was unsuccessful, the whole rotor had to be replaced. To do so, the ducts needed to be removed, the bearings disassembled, a new rotor installed, and the gearbox and motor aligned. The reconditioned rotor was then shop-balanced at low speed. Since this was an overhung flexible rotor, the final results were poor, and two weeks were required to accomplish this rotor replacement.

When the acid plant was out-of-service for two weeks during the rotor replacement, copper production had to be reduced to meet environmental regulations. In 1994, when the DDM2 System was installed, plant personnel had access to continuous machine condition data. Since data is reviewed daily, any malfunction is now detected almost immediately.

Machine saves

After the system was installed, high vibration was detected on the gearbox. The problem was diagnosed as motor/coupling unbalance. A thorough inspection showed that one of the coupling bolts was not standard. Apparently, during assembly, one of the calibrated coupling bolts had been lost, and an ordinary bolt was substituted. When the correct coupling bolt was installed, the problem was solved.

Based on past experience, plant personnel knew that, when the blower vibration increased, it was usually due to unbalance caused by corrosion, abrasion, and particle buildup. The first time each of the three large blowers needed balancing, plant personnel measured the rotor's 1X vibration amplitude and phase data directly from the machine, and compared it to the 1X vibration amplitude and phase data in their trend files. A balance weight was then inserted into the tapped trim-balance holes in the back of the impeller at the same angular location as the high

spot. (The high spot is the location of maximum response with respect to one of the vibration transducers. It was selected because it is opposite the unbalance when the machine runs above the critical (balance resonance) speed.) Using Bently Nevada's Multiplane Balance Software, the influence vectors were computed and stored for use in diagnostics and future balancing attempts.

Easier balancing, less downtime

Plant personnel can now read the 1X vibration amplitudes and phase information from the plots on the DDM2 computer screen (Figures 2a & 2b), so that trim balance weights can be determined before the machine is shut down. Balancing only takes approximately thirty minutes, so the blower is brought back online before the plant needs to be shut down. In the last four years, CODELCO has only replaced one impeller. The other blowers are still operating with their original impellers, which have been field balanced many times. The plant has not been forced to limit its operation, and acid and copper production have remained high.

Economic impact

When the plant is forced to shut down the acid recovery operation for two weeks to install a new rotor in a blower, 1270 tons per day of sulfuric acid cannot be produced, a significant loss of revenue. Two weeks of lost production, plus 48 hours of warm-up time before acid production can begin, would cost approximately $813,000. Parts and time to make the repairs, and reduced output of copper, would bring the cost to over $1,000,000 per event.

If we consider that this system has been in operation almost 4 years and there are three compressors that needed a rotor change twice a year, **the estimated savings would reach more than $20,000,000.** This does not take into consideration the benefits of the reduced environmental impact, which was the main reason why CODELCO decided to install this system.

Conclusions

CODELCO is managing the operation of its blowers very efficiently. The DDM2 System has allowed them to reduce downtime and the cost of repairs. They are very pleased with the DDM2 System, and plan to upgrade to a Data Manager® 2000 System. The El Teniente Division is also installing a new acid plant and is now purchasing a Data Manager 2000 system for managing their Schiele compressors.

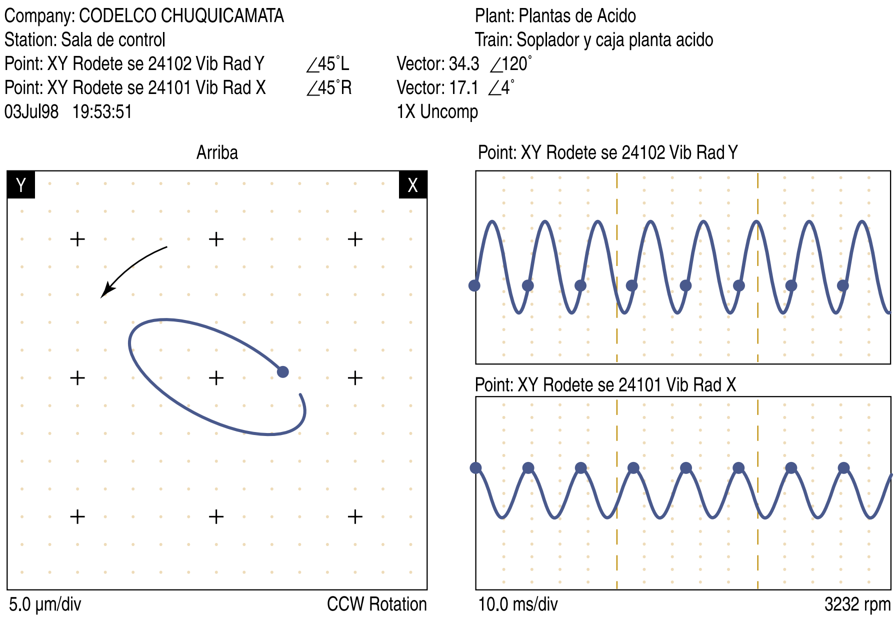

Figure 2a. Vibration response of blower before balancing.

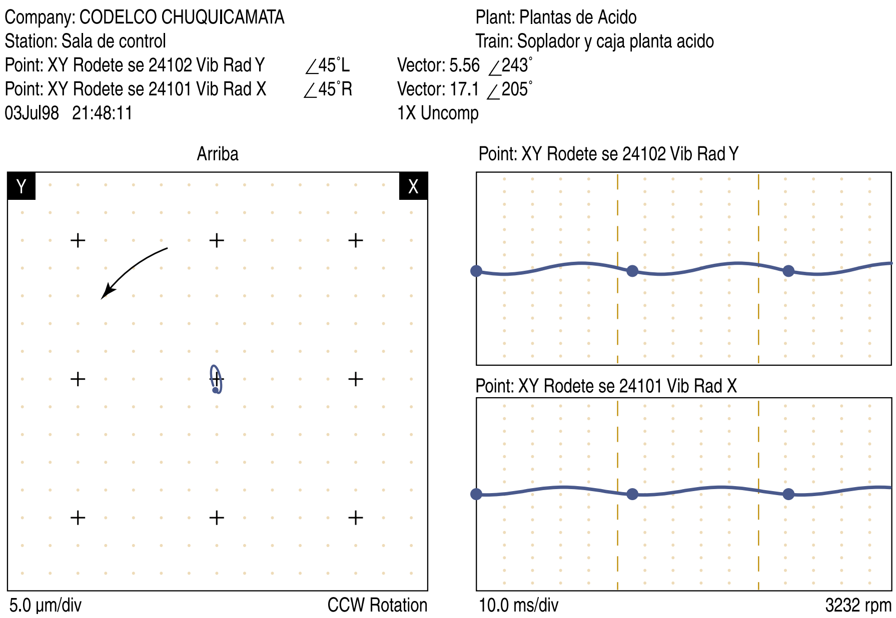

Figure 2b. Vibration response of blower after balancing using influence vectors from Multiplane Balance Software.